



Eugene Nicholas Myers' Lecture on Head and Neck Cancer, 2020: The Surgeon as a Prognostic Factor in Head and Neck Cancer Patients Undergoing Surgery*

Luiz P. Kowalski¹

¹Head and Neck Surgery Department, Faculdade de Medicina da Universidade de São Paulo, São Paulo, SP, Brazil

Address for correspondence Luiz P. Kowalski, MD, PhD, Rua Eneas de Carvalho Aguiar 255, room 8374, 05402-000 São Paulo, Brazil (e-mail: luiz.kowalski@hc.fm.usp.br).

Int Arch Otorhinolaryngol 2023;27(3):e536–e546.

Abstract

This paper is a transcript of the 29th Eugene N. Myers, MD International Lecture on Head and Neck Cancer presented at the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) in 2020. By the end of the 19th century, the survival rate in treated patients was 10%. With the improvements in surgical techniques, currently, about two thirds of patients survive for > 5 years. Teamwork and progress in surgical reconstruction have led to advancements in ablative surgery; the associated adjuvant treatments have further improved the prognosis in the last 30 years. However, prospective trials are lacking; most of the accumulated knowledge is based on retrospective series and some real-world data analyses. Current knowledge on prognostic factors plays a central role in an efficient treatment decision-making process. Although the influence of most tumor- and patient-related prognostic factors in head and neck cancer cannot be changed by medical interventions, some environmental factors—including treatment, decision-making, and quality—can be modified. Ideally, treatment strategy decisions should be taken in dedicated multidisciplinary team meetings. However, evidence suggests that surgeons and hospital volume and specialization play major roles in patient survival after initial or salvage head and neck cancer treatment. The metrics of surgical quality assurance (surgical margins and nodal yield) in neck dissection have a significant impact on survival in head and neck cancer patients and can be influenced by the surgeon's expertise. Strategies proposed to improve surgical quality include continuous performance measurement, feedback, and dissemination of best practice measures.

Keywords

- ▶ head and neck cancer
- ▶ prognosis
- ▶ survival
- ▶ surgeon
- ▶ treatment

* Presented as the 29th Eugene N. Myers, MD International Lecture on Head and Neck Cancer - American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) 2020.

received
August 23, 2022
accepted after revision
September 26, 2022

DOI <https://doi.org/10.1055/s-0043-1761170>.
ISSN 1809-9777.

© 2023. Fundação Otorrinolaringologia. All rights reserved.
This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)
Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Introduction

It is a great honor and a privilege to deliver the Eugene Nicholas Myers Lecture on Head and Neck Cancer. The list of previous distinguished lecturers shows a constellation of 28 of the greatest leaders in our field, starting with John J. Conley, in 1972, to Hisham M. Mehanna, last year. It gave me the opportunity to reflect on the lessons learned during my 40-year journey in head and neck oncology. My first concern was to choose a topic that I have worked on and contributed to and one that will also be of interest to you all.

We are a part of the head and neck oncologic community that must deal with approximately 1.5 million men and women diagnosed with head and neck cancer in 2020 worldwide. In spite of the laudable progress in the diagnosis, staging, and treatment of head and neck cancer over the last 40 years, at least 494,378 people are expected to die from this disease by the end of this year.¹ Most of these patients are expected to die due to aggressive tumor biological behavior or unalterable patient characteristics. However, some of the deaths could be avoided with access to high-quality medical care.

How can surgeons positively affect the outcomes of head and neck cancer patients? The answer is by practicing multidisciplinary, evidence-based medicine and following in the steps of the great surgical leaders, the “masters” in our field.

Prognosis

The Sumerians, 4,000 years ago, and Greeks, by 400 B.C., had recognized that signs and symptoms could predict good or bad outcomes. Predicting the prognosis has always been a challenge for physicians because “...sick people have always been worried about their prospects for recovery...and physicians acquired genuine skill in prognosis long before therapeutics had anything to offer.” Currently, prognosis is defined as an expert prediction of outcome based on an accurate diagnosis, knowledge of natural history of the disease, response to the treatment, and progression of the disease in the patient in question.²

In treated patients “... It is possible to predict survival probabilities in a new patient with head and neck squamous cell carcinoma based on historical results from a data-set analyzed with the Cox regression model. The results... may be used in patient counseling, clinical decision-making, and quality maintenance.”³

Across history, many changes have been incorporated in this concept, and, currently, the concept of prognosis is dynamic, multidimensional, and not limited to life and death. However, in several empirical studies, cure and survival were prioritized in head and neck cancer patients.^{4–8} Even after the completion of planned treatment (during follow-up), the main concern in these patients is the risk of recurrence and death.^{9–12} A study on patients’ preferences showed that most of them considered it important to receive qualitative prognostic information (“curable” or “good prospect”), but some preferred to receive more precise quantitative estimates on their life expectancies.¹³

Prognostic Factors and Treatment Decisions

The management of head and neck cancer patients in everyday clinical practice is based on diagnosis, disease stage, and other prognostic factors that can affect disease outcomes. Prognostic factors have three domains: 1) tumor (site, stage, and histology); 2) patient (age, sex, comorbidities, performance status, and immunity); and 3) environment (socio-economic status, accessible treatment options, and quality of treatment). Knowledge regarding prognostic factors has a central role in an efficient treatment decision-making process.² The influence of most tumor- and patient-related prognostic factors in head and neck cancer cannot be changed by medical intervention.^{3,8,13–26} However, environmental factors, such as treatment decision-making and quality, can be modified, leaving room for improvements.

The tumor-node-metastasis (TNM) staging system uses anatomical prognostic factors to classify tumors, not patients, with some common characteristics. It is the most widely used prognostic system in clinical practice worldwide. Aiming to improve its prognostic ability, Patel and Lydiatt²⁷ proposed the addition of several other factors to the current anatomic-based classification. These included comorbidities, tobacco use, molecular markers, and treatment variables. The 8th edition of the TNM classification included some significant pathological factors (e.g., depth of infiltration for oral cancer and extracapsular spread of lymph node metastases), molecular factors (human papilloma virus [HPV] infection for oropharynx carcinoma), and a patient-related factor (age for thyroid cancer).^{28–30} Although one of the aims of the TNM classification is to allow the comparison of treatments’ efficacy and outcomes in patients treated in different institutions or different geographic regions, the 8th edition of the TNM classification failed to include patient-related factors (comorbidities) and compliance with the current standards and quality of delivered treatment. The American Joint Committee on Cancer (AJCC) acceptance criteria for inclusion of risk models for individualized prognosis in the practice of precision medicine criterium number 12 states the following: “it should be clear which initial treatments were applied...”³¹ Treatment type was included in only 11% of 40 prognostic nomograms based on the AJCC Precision Medicine Core criteria.²⁶

Until the 1980s, in most institutions, the surgeon decided the treatment approach for head and neck cancer patients. Usually, the decision was based on prognostic factors and results of previous experiences with different treatment modalities. Selection of the optimal treatment strategy has increased in complexity owing to the numerous improvements in surgery, radiotherapy, chemotherapy, and immunotherapy. In the present-day scenario, the surgeon is included as a member of a multidisciplinary team.^{32,33} The burden of decision-making is shared among surgeons, medical oncologists, and radiation oncologists and usually is based on tumor- and patient-related factors as well as the expected rates of complications and tumor control.^{34–42} When the level of evidence is weak, local medical culture dictates treatment selection.^{43,44} Furthermore, modern

medical ethics emphasize the patients' right to self-determination: "...under identical external circumstances, different patients reach different decisions based on their personal values."⁴

According to a recent French review³³ on quality insurance in head and neck cancer multidisciplinary team meetings, most patients had undergone surgery before the meeting; the population was different from those included in clinical trials in terms of advanced age and poorer medical conditions. This emphasizes that the "... evidence-based recommendations should be adapted to patients' frailties." It has the obvious advantage of combining the knowledge and expertise of specialists from different fields and has resulted in changes in the management of one third of patients and in improvements in outcomes.⁴²⁻⁴⁸ Dedicated multidisciplinary team meetings are conducted to not only decide the optimal treatment strategy but also to coordinate the care of these patients.^{33,36,37,42,48,49}

The Surgeon's Influence on Prognosis

Progress in the art of surgery is mainly dependent on the talent of courageous and creative surgeons motivated by providing optimal care to patients. Surgeons committed to the welfare of their patients usually form an individualized relationship with the patients and propose treatments that they think are the best for the patient.⁵⁰ There has been extensive criticism regarding the lack of interest in surgeons in performing randomized clinical trials.⁵¹⁻⁵⁶

In recent years, there has been increasing evidence that the surgeon and hospital volumes and specializations play a major role in postoperative complications, mortality, and survival after cancer surgery.⁵⁷⁻⁷⁴ Theodore Kocher, who won a Nobel prize for his work in thyroid surgery, reported a 13% mortality rate in 101 operations performed during the first 10 years of practice; later on, this rate decreased to less than 1%.^{75,76} More than a century later, Adkisson et al.⁷⁶ reviewed 1,249 thyroidectomies performed at the University of Pittsburgh and showed that surgeon volume is an essential consideration. Surgeons who perform more than 30 thyroidectomies a year are more likely to undertake complete initial resection of differentiated thyroid cancer. However, for more advanced disease the threshold is at least 50 operations per year.

Regarding head and neck surgery, a meta-analysis⁶¹ on volume-outcome associations showed conflicting results between the six analyzed series.⁷⁷⁻⁸² Eskander et al.⁶⁶ assessed the influence of surgeon and institution resection volume on long-term overall survival in a cohort of 7,720 head and neck cancer patients treated in Ontario, Canada, from 1993 to 2010. Both hospital and surgeon volumes were significant predictors of improved overall survival rates. There was a 2.4% decrease in the hazard ratio for every additional 25 cases treated in an institution.

Kim et al.⁸³ reported 200 cases (18%) of structural recurrences in a study of 1,103 patients with advanced papillary thyroid carcinoma with lateral nodal metastases who were followed-up for 62 to 108 months (median, 81 months).

Surgeon volume and experience were associated with structural recurrences but not with distant metastases or mortality. The significant impact of surgical volume in thyroid and parathyroid surgery was confirmed by Noureldine et al.⁸⁴ using a large American sample of inpatients (314 cases). However, the data suggest some disparities, and African American patients had less access to intermediate- and high-volume surgeons than Caucasian patients. This was associated with a higher risk of complications, longer length of hospital stay, and higher treatment costs.

The type of treatment facility can also be associated with overall survival in head and neck cancer patients. A population-based retrospective cohort study included 525,740 patients with malignant head and neck tumors registered in the National Cancer Database. The median survival in patients with aerodigestive cancers was 69.2 months. Improved overall survival was associated with treatment in an Academic Comprehensive Cancer Program (hazard ratio [HR], 0.89; 95% confidence interval [CI], 0.88-0.91); Integrated Network Cancer Program (HR, 0.94; 95% CI, 0.92-0.96); and Comprehensive Community Cancer Program (HR, 0.94; 95% CI, 0.92-0.95) compared with treatment at Community Cancer Programs. Survival rates were also lower in patients with government insurance or no insurance, African-Americans or Asians, and patients living in low-income areas.⁸⁵ The practice of head and neck oncology in low-resource settings has restrictions in terms of treatment availability due to the lack of specialized centers. As physicians, we "must do the best we can with what we have."⁸⁶

David et al.⁸⁷ analyzed 46,567 patients with advanced-stage head and neck cancer from the National Cancer Database who underwent curative radiotherapy. Facility volume and academic designation had a significant impact on survival results. Cramer et al.⁷⁴ analyzed 68,856 surgically-treated cases from the same database and reported similar results and conclusions.

Our colleague Oliver Wendell Holmes, who is also a teacher of anatomy, an essayist, and a poet, is one of the founders of the Boston Society for Medical Improvement and has published a collection of Medical Essays: *The Young Knows the Rules but The Old Man Knows the Exceptions*.^{88,89} One should also consider the words of the classical pianist Vladimir Horowitz: "the difference between the ordinary and extraordinary is practice."⁹⁰ This is similar to what surgeons have often repeated for a long time: "practice makes perfect."⁹¹

Surgeons used to be regarded as being very competitive and likely to adopt an authoritative style of leadership.⁹² In more recent years, collaborative teamwork has become the gold standard of medical practice, and in this new environment, flexibility and a high level of emotional intelligence are essential to establish highly functioning teams.⁹³⁻⁹⁵ From 2006 to 2017, a total of 43,939 patients underwent surgeries performed by practicing surgeons from the Michigan Bariatric Surgery Collaborative. Each of the 35 surgeons who completed a lifestyle inventory tool during a meeting had performed 43 to 4,302 procedures (mean: 1,247 procedures). There were lower levels of adverse events when the surgeon

had styles that are highly constructive (i.e., achievement, self-actualizing, humanistic-encouraging, and affiliative) or passive/defensive (i.e., approval, conventional, dependent, and avoidance) compared to patients who underwent surgery performed by surgeons with lower levels of these styles. Surgeons with highly aggressive styles (i.e., perfectionism, competitiveness, power, defiance) had similar rates of post-operative adverse events.⁹⁶ As stated by Drodeck et al. on their 2015 study: “Given the complex nature of personality, however, it is currently impractical to use personality to predict clinical performance.”⁹²

Age is not a contraindication to surgical therapy^{97,98}; however, the surgeon’s attitudes in planning treatment for elderly and young patients may differ, and a large number of them do not receive standard therapy and are treated less aggressively. In some cases, this approach can be explained by the presence of severe uncontrolled comorbidities.^{17,99–102} In other cases, patients and their families can be reluctant to allow surgical procedures.⁹⁹ Clayman et al.⁹⁷ reviewed 43 patients aged ≥ 80 years and found that only 23% of patients received adjuvant treatment. In a control group of younger patients, 44% of patients received adjuvant therapy.

Physician Performance and Prognostic Improvement

The current standard of care for head and neck cancer patients is evidence-based multidisciplinary treatment; however, there is great disparity in the quality of treatment delivery according to the economic status of the geographic region. In parallel, structured surgical training pathways are not used in several low-income countries. Board certifications and quality assurance programs have improved the outcomes of surgical oncology patients in high-income countries; however, such programs have not been fully implemented in low-to-middle-income countries, where surgeons frequently deal with advanced-stage disease and work with limited resources.¹⁰³ To implement international collaboration between the World Health Organization, International Agency for Research on Cancer, International Federation of Oto-Rhino-Laryngological Societies, International Federation of Head and Neck Oncologic Societies, International Academy of Oral Oncology, AAO-HNS, American Head & Neck Society, European Head & Neck Society, and national and regional societies and associations, they aim to improve the educational exchange of curriculum content to enhance residency and fellowship programs, facilitate virtual cancer conferences, and other eHealth activities.^{103–105}

The cutting-edge application of novel technologies in head and neck surgery, such as the robotic or endoscopic surgery, has been introduced in clinical practice worldwide.^{106–109} However, the complexity of using new devices and understanding anatomy from a different perspective is a challenge for young surgeons as well as for experts. Even the most experienced head and neck oncologic surgeons show a long learning curve before gaining expertise in such procedures.^{106,109} For skull-base surgeries, virtual surgical simu-

lation based on models created from the same patient has been considered a useful educational tool.^{110,111}

Quality of Care and Quality Assurance

At the end of the last century, the Institute of Medicine¹¹² defined quality as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.” The Agency for Healthcare Research and Quality defines quality healthcare as “doing the right thing, at the right time, in the right way, for the right person and having the best possible results.” The increasing cost of medical care is a global problem, and this has directed focus to the need to assess the value of the treatment (i.e., quality of care and long-term outcomes achieved at given prices).¹¹³ Porter¹¹⁴ stated that the achievement of high value for patients must become the overarching goal of health care delivery: “... the goal is what matters to patients and unites the interests of all actors in the system.” The use of a non-standard of care increases the utilization of unnecessary resources, and healthcare expenditure in head and neck cancer patients is about 30% higher.¹¹⁵

The main objective of quality assurance is to improve the outcomes of patients through structural and process-related changes in the health system and by ensuring adherence to established procedures.¹¹⁶ Numerous initiatives in quality assurance for head and neck cancer surgery have been proposed by different organizations.^{117–123} The experience of surgeons and patient volume are critical indicators, as reported in several studies.^{61,83,84,116–118,123–131} The higher the patient volume per surgeon, the lower is the long-term mortality.^{61,118,125} Compliance with quality-related metrics was associated with improved survival rates in oral cancer patients who underwent surgical treatment.^{74,132–134} Furthermore, adherence to referral for radiotherapy was significantly associated with overall and disease-free survival.^{74,132,134} The effect of fragmented care was analyzed in 32,813 head and neck cancer patients treated with surgery and postoperative radiotherapy. Patients who underwent adjuvant treatment in a different institution had an increased risk of mortality.¹³⁵

Among the metrics of quality assurance, surgical margins and nodal yield are two of the most significant metrics in head and neck surgery. Both have a significant impact on survival in head and neck cancer patients.^{35,116,132,136,137}

The fundamental principle of radical resection is to obtain adequate exposure that allows good visualization of the entire tumor to ensure the possibility of resection with wide three-dimensional margins, while allowing maximum preservation of normal non-involved tissues. The dimensions vary according to the type and location of the tumor; it must be at least 1 to 2 cm for most squamous cell carcinomas of the upper aerodigestive tract. They can range from 2 mm for glottic squamous cell carcinomas and 5 mm for supraglottic human papillomavirus (HPV)-related oropharynx and basal cell carcinomas of the skin to 2 cm for facial melanomas or 3 cm for sarcomas and carcinomas of the hypopharynx and

cervical esophagus.^{138–140} These margins must include macroscopically healthy tissue; however, frequently, tumors originating in the mucosa involve dysplasia, carcinoma in situ, or even multifocal tumors.¹⁴¹ The surgeon must take into account that visualization as well as palpation are important to achieve adequate resection.

Recent studies have redefined the concept of close surgical margins. Zandoni et al.¹⁴² showed that recurrence-free survival in oral tongue cancer patients was significantly affected only if the surgical margins were 2.2 mm or less. In a study with 10 mongrel dogs, changes in the mucosal and muscle dimensions showed a mean shrinkage from the initial resection to the final microscopic assessment of 30.7% in the deep tongue margin to 47.3% in labiobuccal mucosal margin. Consequently, "...to obtain a 5 mm of pathologically clear margin, an in-situ margin of resection of at least 8 to 10 mm needs to be taken."¹⁴³ Surgical margins of excised specimens of lip and oral squamous cell carcinoma can shrink from 11.3% before excision to 47.5% at histopathologic evaluation.^{144–146}

Nocon et al.¹⁴⁷ analyzed the rates of positive surgical margins in 28,840 head and neck cancer patients registered in the National Cancer Database; the overall positive margin rate was 17.6%. High-volume facilities had lower rates of positive margins (10.8%) than the lowest volume quartile (26.3%) or the two intermediate quartiles (16.5%). The rates of positive margins were lower in academic facilities than in nonacademic facilities (14.0% vs. 22.7%).

A prospective randomized trial compared negative margin rates between two intraoperative methods of margin assessment in oral cancer patients. Frozen section analysis revealed extension of surgical resection in 22 of 51 patients (43%) in the specimen-driven margin arm and in only 2 of 20 patients (10%) in the patient-driven margin arm. The final pathological report showed negative margins in 84% and 55% of patients in the 2 corresponding groups, respectively. The extension of surgical resection prevented the escalation of adjuvant treatment in 38% and 10% of the corresponding patients, respectively.¹⁴⁸ In a multi-institutional study comprising 280 patients with clinical stages I and II oral tongue squamous cell carcinoma, the frequency of positive margins was also lower (7.7%) in the specimen-driven margin group. The patient-driven margin group had worse local control rates.¹⁴⁹

Several strategies have been developed to assess margins in situ, but they all remain to be validated. These include microendoscopy,¹⁵⁰ narrow-band imaging,^{151,152} optical coherence tomography,¹⁵³ fluorescence spectroscopy,^{154,155} Raman spectroscopy,¹⁵⁶ and mass spectrometry.¹⁵⁷

The identification of metastatic lymph nodes in a neck dissection specimen depends on the quality of the neck dissection (surgeon-dependent) as well as on the sampling procedure (pathologist-dependent).^{158–160} The reported lymph node yield in a radical neck specimen varies from 1 to 97 lymph nodes.^{158–162} Lymph node ratio (or lymph node density) is the ratio of the number of involved lymph nodes to the total number of lymph nodes removed during regional lymph node dissection. Thus, it combines the number of

metastatic lymph nodes and the thoroughness of the lymph node dissection.¹⁶³ Higher survival rates in cases involving a lower lymph node ratio have been shown in several human tumors, such as breast cancer,¹⁶³ gastrointestinal cancer,^{164,165} and melanoma.^{166,167} Lymph node ratio has also emerged as an independent prognostic factor for oral squamous cell carcinoma.^{168–170} The prognostic significance of lymph node ratio was validated in a multi-institutional study with 4,254 patients. The overall survival rate was 49% in patients with a lymph node density of < 0.07, compared with 35% in patients with a lymph node density of > 0.07 ($p < 0.001$).¹⁷¹

A patient with 10 dissected lymph nodes and 1 metastatic lymph node has a lymph node ratio of 0.1. A patient with 50 dissected lymph nodes and 1 metastatic lymph node has a lymph node ratio of 0.02. This means that for the same number of metastatic lymph nodes (something that the surgeon cannot interfere with), the prognosis can be improved if a more comprehensive lymph node dissection is performed (something the surgeon can control).

Improvement in Surgical Quality

Arterial encasement, prevertebral involvement, mediastinal involvement, and massive skull-base invasion are considered contraindications to curative surgery. Nowadays, head and neck surgeons can rely on imaging to evaluate if a tumor is resectable or not, thus avoiding futile surgeries.¹⁷² Furthermore, it is important to consider that modern imaging also provides additional information resulting in stage migration, and some current improvements in oncological outcomes may be due to the Will Rogers phenomenon: "Many patients who previously would have been classified in a 'good' stage were assigned to a 'bad' stage. Because the prognosis of those who migrated, although worse than that for other members of the good-stage group, was better than that for other members of the bad-stage group, survival rates rose in each group without any change in individual outcomes."¹⁷³ Stage migration has been documented in head and neck oncology, especially with the introduction of positron emission tomography-computed tomography in the pretreatment workup.^{174–179}

Performance measurement, feedback, and dissemination of best practice measures are among the numerous strategies proposed to improve surgical and medical oncology quality.^{113,127,180–183} In thoracic and general surgery, surgeon-specific outcome reports allow individualized performance evaluation and feedback provision.^{127,180,184,185}

Randall Weber,¹¹⁵ in his American Head and Neck Society Presidential Address "Improving the quality of head and neck cancer care" stated "... we have a unique opportunity and a societal obligation to reengineer head and neck cancer care for the betterment of our patients..." His recommendations for improving the quality of care in head and neck oncology were as follows: a) training using residency and fellowship programs, b) creation of multidisciplinary head and neck cancer teams, c) participation in national initiatives to improve the quality of cancer care, d) directing patients

with head and neck cancer to tertiary care facilities, e) dissemination and implementation of NCCN treatment guidelines for head and neck cancer, and f) supporting the enrollment of patients in prospective clinical trials to promote the provision of evidence-based treatment and the development of new therapeutic paradigms in head and neck oncology.

In a program for evaluating head and neck surgical performance indicators at an individual and departmental level at the MD Anderson Cancer Center, University of Texas, performance monitoring and feedback interventions were shown to improve surgical performance. The length of hospital stay decreased from 2.1 to 1.5 days for low acuity procedures and from 10.5 to 7 days for high acuity procedures; the incidence rate of negative performance indicators decreased from 39.1 to 28.6%.^{186–188} Lira et al.¹⁸⁹ analyzed 360 head and neck cancer patients treated in a Brazilian cancer center and achieved the MD Anderson benchmarks for all outcome indicators in low acuity procedures, but the rate of surgical site infection was higher and the length of hospital stay was longer in high-acuity procedures.

Cramer et al.⁷⁴ investigated 5 quality metrics of adherence to the NCCN guidelines in 76,853 surgically treated patients with head and neck cancer identified from the National Cancer Database. The patients were treated in 1,217 hospitals from 2004 to 2014. Negative surgical margins were noted in 80% of cases. Among the 41,572 patients who underwent neck dissection, 78.1% had 18 or more excised lymph nodes. From among 31,442 patients who had T3 to T4 or N2 to N3 disease, 69% received adjuvant radiotherapy, and among 17,789 patients with positive margins or extracapsular extension, only 42.6% received adjuvant chemoradiotherapy; adjuvant treatment was started within 6 weeks of surgery in only 44.5% of 35,716 cases. All five parameters had a significant impact on prognosis. The mean overall quality score for the studied patients was 70.7%, and high-quality care was associated with a reduced risk of mortality (HR 0.81; 95% CI 0.79–0.83). These results strongly suggest that adherence to these metrics could improve survival in head and neck cancer patients. Schoppy et al.¹³⁴ also analyzed data from the National Cancer Database and showed that 90% of rates of negative margins and 80% the number of 18 or more lymph nodes in neck dissection specimens identified the subset of high-quality hospitals associated with significant survival advantages when compared with other hospitals.

There is some evidence confirming the hypothesis that observation improves the results of surgeons.^{127,190} This phenomenon is known as the Hawthorne effect. During the 1920s and 1930s, at Western Electric's Hawthorne Works electric company, Hawthorne, Illinois, the effect of different aspects of the work environment (lighting, breaks, etc.) on worker's productivity was studied. None of the conditions explained why the productivity had increased during the experiment and decreased after it ended. It was later shown that during the experiment, workers were responding to increased attention from the supervisors and not to any of the experimental variables. The changes were actually psychological; the workers' responses were influenced by the

special attention and by knowledge of the ongoing experiment.^{190,191}

Conclusion

Multidisciplinary tumor board meetings are the current gold standard for treatment planning in head and neck oncology, and compliance with recommended treatments has a significant impact on prognosis.

With regard to surgeons, training, specialization, experience, volume, attitudes, and performance are significant prognostic factors in several human cancers. Structured educational and quality assurance programs must be undertaken with the aim of improving surgical quality and the patient's outcomes.

There is limited literature on the surgeon's role in the prognosis of head and neck cancer patients. Thus, quality audits of the surgeon's performance, such as in terms of surgical margins, lymph node yield or lymph node ratio, complications, postoperative mortality, adherence to established guidelines, participation in multidisciplinary boards, and compliance with the board's decision, must be implemented.

Hospital and surgeon volume are the benchmarks of quality care because of their significant impact on postoperative complications and overall survival. It is critical to identify other variables associated with survival rates and the quality of life; then, modifications related to these variables should be promoted in surgical practice. However, these factors are not easily transferable, suggesting that the centralization of care in high-volume universities, research centers, and cancer centers can improve outcomes after head and neck oncologic treatment.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author declares that there is no conflict of interests.

Author Contribution

The author was the only responsible for the conception, literature review, and manuscript preparation.

References

- 1 Global Cancer Observatory (GLOBOCAN). International Agency for Research on Cancer, 2020. May 20, 2020. <http://www.gco.iarc.fr>
- 2 Gospodarowicz MK, Honson DE, Hutter RVP, O'Sullivan B, Lobin LH, Wittekind C. Prognostic Factors in Cancer. New York, USA: Wiley-Liss; 2001:809
- 3 Baatenburg de Jong RJ, Hermans J, Molenaar J, Briaire JJ, le Cessie S. Prediction of survival in patients with head and neck cancer. *Head Neck* 2001;23(09):718–724
- 4 Windon MJ, D'Souza G, Faraji F, et al. Priorities, concerns, and regret among patients with head and neck cancer. *Cancer* 2019; 125(08):1281–1289

- 5 List MA, Stracks J, Colangelo L, et al. How Do head and neck cancer patients prioritize treatment outcomes before initiating treatment? *J Clin Oncol* 2000;18(04):877–884
- 6 Gill SS, Frew J, Fry A, et al. Priorities for the head and neck cancer patient, their companion and members of the multidisciplinary team and decision regret. *Clin Oncol (R Coll Radiol)* 2011;23(08):518–524
- 7 List MA, Rutherford JL, Stracks J, et al. Prioritizing treatment outcomes: head and neck cancer patients versus nonpatients. *Head Neck* 2004;26(02):163–170
- 8 van der Schroeff MP, Steyerberg EW, Wieringa MH, Langeveld TP, Molenaar J, Baatenburg de Jong RJ. Prognosis: a variable parameter: dynamic prognostic modeling in head and neck squamous cell carcinoma. *Head Neck* 2012;34(01):34–41
- 9 Kanatas A, Ghazali N, Lowe D, et al. Issues patients would like to discuss at their review consultation: variation by early and late stage oral, oropharyngeal and laryngeal subsites. *Eur Arch Otorhinolaryngol* 2013;270(03):1067–1074
- 10 Rogers SN, Thomson F, Lowe D. The Patient Concerns Inventory integrated as part of routine head and neck cancer follow-up consultations: frequency, case-mix, and items initiated by the patient. *Ann R Coll Surg Engl* 2018;100(03):209–215
- 11 Jungerman I, Toyota J, Montoni NP, et al. Patient Concerns Inventory for head and neck cancer: Brazilian cultural adaptation. *Rev Assoc Med Bras* 2017;63(04):311–319
- 12 Rogers SN, Alvear A, Anesi A, et al. Variations in concerns reported on the patient concerns inventory in patients with head and neck cancer from different health settings across the world. *Head Neck* 2020;42(03):498–512
- 13 Hoesseini A, Dronkers EAC, Sewnaik A, Hardillo JAU, Baatenburg de Jong RJ, Offerman MPJ. Head and neck cancer patients' preferences for individualized prognostic information: a focus group study. *BMC Cancer* 2020;20(01):399
- 14 Carvalho AL, Nishimoto IN, Califano JA, Kowalski LP. Trends in incidence and prognosis for head and neck cancer in the United States: a site-specific analysis of the SEER database. *Int J Cancer* 2005;114(05):806–816
- 15 Carvalho AL, Ikeda MK, Magrin J, Kowalski LP. Trends of oral and oropharyngeal cancer survival over five decades in 3267 patients treated in a single institution. *Oral Oncol* 2004;40(01):71–76
- 16 Cooper JS, Porter K, Mallin K, et al. National Cancer Database report on cancer of the head and neck: 10-year update. *Head Neck* 2009;31(06):748–758
- 17 Sanabria A, Carvalho AL, Vartanian JG, Magrin J, Ikeda MK, Kowalski LP. Factors that influence treatment decision in older patients with resectable head and neck cancer. *Laryngoscope* 2007;117(05):835–840
- 18 Ribeiro KC, Kowalski LP, Latorre MR. Impact of comorbidity, symptoms, and patients' characteristics on the prognosis of oral carcinomas. *Arch Otolaryngol Head Neck Surg* 2000;126(09):1079–1085
- 19 Pugliano FA, Piccirillo JF, Zequeira MR, Fredrickson JM, Perez CA, Simpson JR. Clinical-severity staging system for oral cavity cancer: five-year survival rates. *Otolaryngol Head Neck Surg* 1999;120(01):38–45
- 20 Piccirillo JF. Importance of comorbidity in head and neck cancer. *Laryngoscope* 2015;125(10):2242
- 21 Peterson LA, Bellile EL, Wolf GT, et al; University of Michigan Head and Neck Specialized Program of Research Excellence Program. Cigarette use, comorbidities, and prognosis in a prospective head and neck squamous cell carcinoma population. *Head Neck* 2016;38(12):1810–1820
- 22 Habbous S, Harland LT, La Delfa A, et al. Comorbidity and prognosis in head and neck cancers: Differences by subsite, stage, and human papillomavirus status. *Head Neck* 2014;36(06):802–810
- 23 Okuyemi OT, Piccirillo JF, Spitznagel E. TNM staging compared with a new clinicopathological model in predicting oral tongue squamous cell carcinoma survival. *Head Neck* 2014;36(10):1481–1489
- 24 Winquist E, Agbassi C, Meyers BM, Yoo J, Chan KKW. Head and Neck Disease Site Group. Systemic therapy in the curative treatment of head and neck squamous cell cancer: a systematic review. *J Otolaryngol Head Neck Surg* 2017;46(01):29
- 25 Gordon SA, Reiter ER. Effectiveness of critical care pathways for head and neck cancer surgery: A systematic review. *Head Neck* 2016;38(09):1421–1427
- 26 Tham T, Machado R, Herman SW, Kraus D, Costantino P, Roche A. Personalized prognostication in head and neck cancer: A systematic review of nomograms according to the AJCC precision medicine core (PMC) criteria. *Head Neck* 2019;41(08):2811–2822
- 27 Patel SG, Lydiatt WM. Staging of head and neck cancers: is it time to change the balance between the ideal and the practical? *J Surg Oncol* 2008;97(08):653–657
- 28 Pan JJ, Ng WT, Zong JF, et al. Prognostic nomogram for refining the prognostication of the proposed 8th edition of the AJCC/UICC staging system for nasopharyngeal cancer in the era of intensity-modulated radiotherapy. *Cancer* 2016;122(21):3307–3315
- 29 Zanon DK, Patel SG. New AJCC: How does it impact oral cancers? *Oral Oncol* 2020;104:104607
- 30 Lydiatt WM, Patel SG, O'Sullivan B, et al. Head and Neck cancers—major changes in the American Joint Committee on cancer eighth edition cancer staging manual. *CA Cancer J Clin* 2017;67(02):122–137
- 31 Kattan MW, Hess KR, Amin MB, et al; members of the AJCC Precision Medicine Core. American Joint Committee on Cancer acceptance criteria for inclusion of risk models for individualized prognosis in the practice of precision medicine. *CA Cancer J Clin* 2016;66(05):370–374
- 32 Andry G, Hamoir M, Leemans CR. The evolving role of surgery in the management of head and neck tumors. *Curr Opin Oncol* 2005;17(03):241–248
- 33 Guy JB, Benna M, Xia Y, et al. Quality insurance in head and neck cancer multidisciplinary team meetings: A watchful eye on real-life experience. *Oral Oncol* 2019;91:35–38
- 34 Hassett MJ. Quality improvement in the era of big data. *J Clin Oncol* 2017;35(28):3178–3180
- 35 Graboyes EM, Townsend ME, Kallogjeri D, Piccirillo JF, Nussenbaum B. Evaluation of quality metrics for surgically treated laryngeal squamous cell carcinoma. *JAMA Otolaryngol Head Neck Surg* 2016;142(12):1154–1163
- 36 Hughes C, Homer J, Bradley P, et al. An evaluation of current services available for people diagnosed with head and neck cancer in the UK (2009–2010). *Clin Oncol (R Coll Radiol)* 2012;24(10):e187–e192
- 37 Deneuve S, Babin E, Lacau-St-Guilly J, et al. Guidelines (short version) of the French Otorhinolaryngology - Head and Neck Surgery Society (SFORL) on patient pathway organization in ENT: The therapeutic decision-making process. *Eur Ann Otorhinolaryngol Head Neck Dis* 2015;132(04):213–215
- 38 Friedland PL, Bozic B, Dewar J, Kuan R, Meyer C, Phillips M. Impact of multidisciplinary team management in head and neck cancer patients. *Br J Cancer* 2011;104(08):1246–1248
- 39 Hoban CW, Beesley LJ, Bellile EL, et al. Individualized outcome prognostication for patients with laryngeal cancer. *Cancer* 2018;124(04):706–716
- 40 Myers EN. Head and neck oncology–2010, Part I. *Otolaryngol Pol* 2010;64(03):136–146
- 41 Myers EN. Head and neck oncology–2010, part II. *Otolaryngol Pol* 2010;64(04):204–214
- 42 Kirkegård J, Aahlin EK, Al-Saiddi M, et al. Multicentre study of multidisciplinary team assessment of pancreatic cancer resectability and treatment allocation. *Br J Surg* 2019;106(06):756–764
- 43 Grünwald V, Chirovsky D, Cheung WY et al; GLANCE H&N STUDY Investigators. Global treatment patterns and outcomes among

- patients with recurrent and/or metastatic head and neck squamous cell carcinoma: Results of the GLANCE H&N study. *Oral Oncol* 2020;102:104526
- 44 O'Sullivan B, Mackillop W, Gilbert R, et al. Controversies in the management of laryngeal cancer: results of an international survey of patterns of care. *Radiother Oncol* 1994;31(01):23–32
 - 45 van Overveld LFJ, Braspenning JCC, Hermens RPMG. Quality indicators of integrated care for patients with head and neck cancer. *Clin Otolaryngol* 2017;42(02):322–329
 - 46 Westin T, Stalfors J. Tumour boards/multidisciplinary head and neck cancer meetings: are they of value to patients, treating staff or a political additional drain on healthcare resources? *Curr Opin Otolaryngol Head Neck Surg* 2008;16(02):103–107
 - 47 Stalfors J, Lundberg C, Westin T. Quality assessment of a multidisciplinary tumour meeting for patients with head and neck cancer. *Acta Otolaryngol* 2007;127(01):82–87
 - 48 Shellenberger TD, Weber RS. Multidisciplinary team planning for patients with head and neck cancer. *Oral Maxillofac Surg Clin North Am* 2018;30(04):435–444
 - 49 Licitra L, Keilholz U, Tahara M, et al. Evaluation of the benefit and use of multidisciplinary teams in the treatment of head and neck cancer. *Oral Oncol* 2016;59:73–79
 - 50 Snow GB. Evaluation of new treatment methods for head and neck cancer: a challenge. *Acta Otolaryngol* 1989;107(5-6):352–356
 - 51 Ridge JA. We show pictures, they show curves. *Arch Otolaryngol Head Neck Surg* 2010;136(12):1170–1175
 - 52 Torgerson T, Johnson AL, Jellison S, et al. Reporting of Clinical Trial Interventions Published in Leading Otolaryngology-Head and Neck Surgery Journals. *Laryngoscope* 2020;130(09):E507–E514. Doi: 10.1002/lary.28404. [published online ahead of print, 2019 Nov 20]
 - 53 Wasserman JM, Wynn R, Bash TS, Rosenfeld RM. Levels of evidence in otolaryngology journals. *Otolaryngol Head Neck Surg* 2006;134(05):717–723
 - 54 Bentsianov BL, Boruk M, Rosenfeld RM. Evidence-based medicine in otolaryngology journals. *Otolaryngol Head Neck Surg* 2002;126(04):371–376
 - 55 Huang YQ, Traore K, Ibrahim B, Sewitch MJ, Nguyen LHP. Reporting quality of randomized controlled trials in otolaryngology: review of adherence to the CONSORT statement. *J Otolaryngol Head Neck Surg* 2018;47(01):34
 - 56 Kaper NM, Ramakers GGJ, Aarts MCJ, van der Heijden GJMG. Publications on clinical research in otolaryngology—A systematic analysis of leading journals in 2010. *Front Surg* 2019;6:18
 - 57 Lerut T. The surgeon as a prognostic factor. *Ann Surg* 2000;232(06):729–732
 - 58 Begg CB, Cramer LD, Hoskins WJ, Brennan MF. Impact of hospital volume on operative mortality for major cancer surgery. *JAMA* 1998;280(20):1747–1751
 - 59 Neoptolemos JP, Russell RCG, Bramhall S, Theis BUK Pancreatic Cancer Group. Low mortality following resection for pancreatic and periampullary tumours in 1026 patients: UK survey of specialist pancreatic units. *Br J Surg* 1997;84(10):1370–1376
 - 60 van Lanschot JJ, Rutten HJ, Boom RP, Gouma DJ. [Importance of regional surgery networks]. *Ned Tijdschr Geneesk* 2000;144(24):1148–1152
 - 61 Eskander A, Merdad M, Irish JC, et al. Volume-outcome associations in head and neck cancer treatment: a systematic review and meta-analysis. *Head Neck* 2014;36(12):1820–1834
 - 62 Birkmeyer JD, Siewers AE, Finlayson EV, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med* 2002;346(15):1128–1137
 - 63 Birkmeyer JD, Stukel TA, Siewers AE, Goodney PP, Wennberg DE, Lucas FL. Surgeon volume and operative mortality in the United States. *N Engl J Med* 2003;349(22):2117–2127
 - 64 Simunovic M, Rempel E, Thériault ME, et al. Influence of hospital characteristics on operative death and survival of patients after major cancer surgery in Ontario. *Can J Surg* 2006;49(04):251–258
 - 65 Urbach DR, Bell CM, Austin PC. Differences in operative mortality between high- and low-volume hospitals in Ontario for 5 major surgical procedures: estimating the number of lives potentially saved through regionalization. *CMAJ* 2003;168(11):1409–1414
 - 66 Eskander A, Irish J, Groome PA, et al. Volume-outcome relationships for head and neck cancer surgery in a universal health care system. *Laryngoscope* 2014;124(09):2081–2088
 - 67 Kauppila JH, Wahlin K, Lagergren P, Lagergren J. University hospital status and surgeon volume and risk of reoperation following surgery for esophageal cancer. *Eur J Surg Oncol* 2018;44(05):632–637
 - 68 Iwatsuki M, Yamamoto H, Miyata H, et al. Effect of hospital and surgeon volume on postoperative outcomes after distal gastrectomy for gastric cancer based on data from 145,523 Japanese patients collected from a nationwide web-based data entry system. *Gastric Cancer* 2019;22(01):190–201
 - 69 Wallis CJ, Ravi B, Coburn N, Nam RK, Detsky AS, Satkunasingam R. Comparison of postoperative outcomes among patients treated by male and female surgeons: a population based matched cohort study. *BMJ* 2017;359:j4366
 - 70 Gourin CG, Forastiere AA, Sanguineti G, Koch WM, Marur S, Bristow RE. Impact of surgeon and hospital volume on short-term outcomes and cost of laryngeal cancer surgical care. *Laryngoscope* 2011;121(01):85–90
 - 71 Renzulli P, Laffer UT. Learning curve: the surgeon as a prognostic factor in colorectal cancer surgery. *Recent Results Cancer Res* 2005;165:86–104
 - 72 Liu JB, Huffman KM, Palis BE, et al. Reliability of the American College of Surgeons Commission on Cancer's quality of care measures for hospital and surgeon profiling. *J Am Coll Surg* 2017;224(02):180–190.e8
 - 73 Yi D, Monson JRT, Stankiewicz CC, Atallah S, Finkler NJ. Impact of colorectal surgeon case volume on outcomes and applications to quality improvement. *Int J Colorectal Dis* 2018;33(05):635–644
 - 74 Cramer JD, Speedy SE, Ferris RL, Rademaker AW, Patel UA, Samant S. National evaluation of multidisciplinary quality metrics for head and neck cancer. *Cancer* 2017;123(22):4372–4381
 - 75 Pasięka JL. The surgeon as a prognostic factor in endocrine surgical diseases. *Surg Oncol Clin N Am* 2000;9(01):13–20, v–vi
 - 76 Adkisson CD, Howell GM, McCoy KL, et al. Surgeon volume and adequacy of thyroidectomy for differentiated thyroid cancer. *Surgery* 2014;156(06):1453–1459, discussion 1460
 - 77 Cheung MC, Koniaris LG, Perez EA, Molina MA, Goodwin WJ, Salloum RM. Impact of hospital volume on surgical outcome for head and neck cancer. *Ann Surg Oncol* 2009;16(04):1001–1009
 - 78 Sharma A, Schwartz SM, Méndez E. Hospital volume is associated with survival but not multimodality therapy in Medicare patients with advanced head and neck cancer. *Cancer* 2013;119(10):1845–1852
 - 79 Chen AY, Pavluck A, Halpern M, Ward E. Impact of treating facilities' volume on survival for early-stage laryngeal cancer. *Head Neck* 2009;31(09):1137–1143
 - 80 Chen AY, Fedewa S, Pavluck A, Ward EM. Improved survival is associated with treatment at high-volume teaching facilities for patients with advanced stage laryngeal cancer. *Cancer* 2010;116(20):4744–4752
 - 81 Lee CC, Ho HC, Chou P. Multivariate analyses to assess the effect of surgeon volume on survival rate in oral cancer: a nationwide population-based study in Taiwan. *Oral Oncol* 2010;46(04):271–275
 - 82 Lin CC, Lin HC. Effects of surgeon and hospital volume on 5-year survival rates following oral cancer resections: the experience of an Asian country. *Surgery* 2008;143(03):343–351
 - 83 Kim HI, Kim TH, Choe JH, et al. Surgeon volume and prognosis of patients with advanced papillary thyroid cancer and lateral nodal metastasis. *Br J Surg* 2018;105(03):270–278

- 84 Noureldine SI, Abbas A, Tufano RP, et al. The impact of surgical volume on racial disparity in thyroid and parathyroid surgery. *Ann Surg Oncol* 2014;21(08):2733–2739
- 85 Carey RM, Fathy R, Shah RR, et al. Association of type of treatment facility with overall survival after a diagnosis of head and neck cancer. *JAMA Netw Open* 2020;3(01):e1919697
- 86 Kowalski LP, Sanabria A. Priority setting in head and neck oncology in low-resource environments. *Curr Opin Otolaryngol Head Neck Surg* 2019;27(03):198–202
- 87 David JM, Ho AS, Luu M, et al. Treatment at high-volume facilities and academic centers is independently associated with improved survival in patients with locally advanced head and neck cancer. *Cancer* 2017;123(20):3933–3942
- 88 Dunn PM. Oliver Wendell Holmes (1809-1894) and his essay on puerperal fever. *Arch Dis Child Fetal Neonatal Ed* 2007;92(04):F325–F327
- 89 Holmes OW. *Medical Essays, 1842–1882*. Boston, Houghton: Mifflin and Co; 1883
- 90 Yamashita S, Conrad C. A prognostic factor under the surgeon's control. *JAMA Surg* 2017;152(04):393
- 91 Liu CJ, Chou YJ, Teng CJ, et al. Association of surgeon volume and hospital volume with the outcome of patients receiving definitive surgery for colorectal cancer: A nationwide population-based study. *Cancer* 2015;121(16):2782–2790
- 92 Drosdeck JM, Osayi SN, Peterson LA, Yu L, Ellison EC, Muscarella P. Surgeon and nonsurgeon personalities at different career points. *J Surg Res* 2015;196(01):60–66
- 93 Emanuel EJ, Gudbranson E. Does medicine overemphasize IQ? *JAMA* 2018;319(07):651–652
- 94 Leach LS, Myrtle RC, Weaver FA. Surgical teams: role perspectives and role dynamics in the operating room. *Health Serv Manage Res* 2011;24(02):81–90
- 95 Birkmeyer JD, Finks JF, O'Reilly A, et al; Michigan Bariatric Surgery Collaborative. Surgical skill and complication rates after bariatric surgery. *N Engl J Med* 2013;369(15):1434–1442
- 96 Shubeck SP, Kanters AE, Dimick JB. Surgeon leadership style and risk-adjusted patient outcomes. *Surg Endosc* 2019;33(02):471–474
- 97 Clayman GL, Eicher SA, Sicard MW, Razmpa E, Goepfert H. Surgical outcomes in head and neck cancer patients 80 years of age and older. *Head Neck* 1998;20(03):216–223
- 98 McQuirt WF, Loevy S, McCabe BF, Krause CJ. The risks of major head and neck surgery in the aged population. *Laryngoscope* 1977;87(08):1378–1382
- 99 Genden EM, Rinaldo A, Shaha AR, et al. Treatment considerations for head and neck cancer in the elderly. *J Laryngol Otol* 2005;119(03):169–174
- 100 Sanabria A, Carvalho AL, Vartanian JG, Magrin J, Ikeda MK, Kowalski LP. Validation of the Washington University head and neck comorbidity index in a cohort of older patients. *Arch Otolaryngol Head Neck Surg* 2008;134(06):603–607
- 101 Sanabria A, Carvalho AL, Vartanian JG, Magrin J, Ikeda MK, Kowalski LP. Comorbidity is a prognostic factor in elderly patients with head and neck cancer. *Ann Surg Oncol* 2007;14(04):1449–1457
- 102 Kowalski LP, Alcantara PS, Magrin J, Parise Júnior O. A case-control study on complications and survival in elderly patients undergoing major head and neck surgery. *Am J Surg* 1994;168(05):485–490
- 103 Hoekstra HJ, Wobbes T, Heineman E, Haryono S, Aryandono T, Balch CM. Fighting global disparities in cancer care: A surgical oncology view. *Ann Surg Oncol* 2016;23(07):2131–2136
- 104 Poston GJ. Global cancer surgery: The Lancet Oncology review. *Eur J Surg Oncol* 2015;41(12):1559–1561
- 105 Brennan M. The role of U.S. cancer centers in global cancer care. *Ann Surg Oncol* 2015;22(03):747–749
- 106 Kim WS, Ban MJ, Chang JW, et al. Learning curve for robot-assisted neck dissection in head and neck cancer: a 3-year prospective case study and analysis. *JAMA Otolaryngol Head Neck Surg* 2014;140(12):1191–1197
- 107 Weinstein GS, O'Malley BW Jr, Snyder W, Sherman E, Quon H. Transoral robotic surgery: radical tonsillectomy. *Arch Otolaryngol Head Neck Surg* 2007;133(12):1220–1226
- 108 Chia SH, Gross ND, Richmon JD. Surgeon experience and complications with transoral robotic surgery (TORS). *Otolaryngol Head Neck Surg* 2013;149(06):885–892
- 109 Albergotti WG, Gooding WE, Kubik MW, et al. Assessment of surgical learning curves in transoral robotic surgery for squamous cell carcinoma of the oropharynx. *JAMA Otolaryngol Head Neck Surg* 2017;143(06):542–548
- 110 Oishi M, Fukuda M, Yajima N, et al. Interactive presurgical simulation applying advanced 3D imaging and modeling techniques for skull base and deep tumors. *J Neurosurg* 2013;119(01):94–105
- 111 Nishio N, Fujii M, Hayashi Y, et al. Preoperative surgical simulation and validation of the line of resection in anterolateral craniofacial resection of advanced sinonasal sinus carcinoma. *Head Neck* 2017;39(03):512–519
- 112 Hewitt ME, Simone JV. *Ensuring Quality Cancer Care*. Washington DC, USA: National Academy Press; 1999: ix, 246.
- 113 Takes RP, Halmos GB, Ridge JA et al. Value and quality of care in head and neck oncology. *Curr Oncol Rep* 2020;22(09):92
- 114 Porter ME. What is value in health care? *N Engl J Med* 2010;363(26):2477–2481
- 115 Weber RS. Improving the quality of head and neck cancer care. *Arch Otolaryngol Head Neck Surg* 2007;133(12):1188–1192
- 116 Simon C, Caballero C. Quality assurance and improvement in head and neck cancer surgery: From clinical trials to national healthcare initiatives. *Curr Treat Options Oncol* 2018;19(07):34
- 117 Simon C, Dietz A, Leemans CR. Quality assurance in head and neck cancer surgery: where are we, and where are we going? *Curr Opin Otolaryngol Head Neck Surg* 2019;27(02):151–156
- 118 Simon C, Caballero C, Gregoire V, et al. Surgical quality assurance in head and neck cancer trials: an EORTC Head and Neck Cancer Group position paper based on the EORTC 1420 'Best of' and 24954 'larynx preservation' study. *Eur J Cancer* 2018;103:69–77
- 119 Jacobs JR, Pajak TF, Weymuller E, Sessions D, Schuller DE. Development of surgical quality-control mechanisms in large-scale prospective trials: head and neck intergroup report. *Head Neck* 1991;13(01):28–32
- 120 Jacobs JR, Pajak TF, Snow JB, Lowry LD, Kramer S. Surgical quality control in head and neck cancer. Study 73-03 of the Radiation Therapy Oncology Group. *Arch Otolaryngol Head Neck Surg* 1989;115(04):489–493
- 121 Lewis CM, Weber RS, Hanna EY. Quality of care in head and neck cancer. *Curr Oncol Rep* 2011;13(02):120–125
- 122 Neuss MN, Desch CE, McNiff KK, et al. A process for measuring the quality of cancer care: the Quality Oncology Practice Initiative. *J Clin Oncol* 2005;23(25):6233–6239
- 123 Nouraei SA, Middleton SE, Hudovsky A, et al. A national analysis of the outcome of major head and neck cancer surgery: implications for surgeon-level data publication. *Clin Otolaryngol* 2013;38(06):502–511
- 124 Gourin CG, Tufano RP, Forastiere AA, Koch WM, Pawlik TM, Bristow RE. Volume-based trends in thyroid surgery. *Arch Otolaryngol Head Neck Surg* 2010;136(12):1191–1198
- 125 Bhoday J, Martling A, Straßburg J, Brown G. Session 1: The surgeon as a prognostic factor in colon and rectal cancer? *Colorectal Dis* 2018;20(Suppl 1):36–38
- 126 Peyronnet B, Tondut L, Bernhard JC, et al; members of the French Committee of Urologic Oncology (CCAFU) Impact of hospital volume and surgeon volume on robot-assisted partial nephrectomy outcomes: a multicentre study. *BJU Int* 2018;121(06):916–922
- 127 Pera M. The surgeon as a risk factor: the need for shared individual outcome reports and quality improvement strategies. *Colorectal Dis* 2016;18(06):533–534

- 128 Meltzer C, Klau M, Gurushanthaiah D, et al. Surgeon volume in parathyroid surgery-surgical efficiency, outcomes, and utilization. *JAMA Otolaryngol Head Neck Surg* 2017;143(08):843–847
- 129 Meltzer C, Klau M, Gurushanthaiah D, et al. Surgeon volume in thyroid surgery: Surgical efficiency, outcomes, and utilization. *Laryngoscope* 2016;126(11):2630–2639
- 130 Nouraei SA, Virk JS, Middleton SE, et al. A national analysis of trends, outcomes and volume-outcome relationships in thyroid surgery. *Clin Otolaryngol* 2017;42(02):354–365
- 131 Nouraei SA, Mace AD, Middleton SE, et al. A stratified analysis of the perioperative outcome of 17623 patients undergoing major head and neck cancer surgery in England over 10 years: Towards an Informatics-based Outcomes Surveillance Framework. *Clin Otolaryngol* 2017;42(01):11–28
- 132 Graboyes EM, Gross J, Kallogjeri D, et al. Association of compliance with process-related quality metrics and improved survival in oral cavity squamous cell carcinoma. *JAMA Otolaryngol Head Neck Surg* 2016;142(05):430–437
- 133 Hessel AC, Moreno MA, Hanna EY, et al. Compliance with quality assurance measures in patients treated for early oral tongue cancer. *Cancer* 2010;116(14):3408–3416
- 134 Schoppy DW, Rhoads KF, Ma Y, et al. Measuring institutional quality in head and neck surgery using hospital-level data: Negative margin rates and neck dissection yield. *JAMA Otolaryngol Head Neck Surg* 2017;143(11):1111–1116
- 135 Chen MM, Megwalu UC, Liew J, Sirjani D, Rosenthal EL, Divi V. Regionalization of head and neck cancer surgery may fragment care and impact overall survival. *Laryngoscope* 2019;129(06):1413–1419
- 136 Divi V, Chen MM, Nussenbaum B, et al. Lymph node count from neck dissection predicts mortality in head and neck cancer. *J Clin Oncol* 2016;34(32):3892–3897
- 137 Li MM, Puram SV, Silverman DA, Old MO, Rocco JW, Kang SY. Margin analysis in head and neck cancer: State of the art and future directions. *Ann Surg Oncol* 2019;26(12):4070–4080
- 138 Hinni ML, Ferlito A, Brandwein-Gensler MS, et al. Surgical margins in head and neck cancer: a contemporary review. *Head Neck* 2013;35(09):1362–1370
- 139 Thomas Robbins K, Triantafyllou A, Suárez C, et al. Surgical margins in head and neck cancer: Intra- and postoperative considerations. *Auris Nasus Larynx* 2019;46(01):10–17
- 140 Meier JD, Oliver DA, Varvares MA. Surgical margin determination in head and neck oncology: current clinical practice. The results of an International American Head and Neck Society Member Survey. *Head Neck* 2005;27(11):952–958
- 141 Leemans CR, Braakhuis BJ, Brakenhoff RH. The molecular biology of head and neck cancer. *Nat Rev Cancer* 2011;11(01):9–22
- 142 Zanoni DK, Migliacci JC, Xu B, et al. A proposal to redefine close surgical margins in squamous cell carcinoma of the oral tongue. *JAMA Otolaryngol Head Neck Surg* 2017;143(06):555–560
- 143 Johnson RE, Sigman JD, Funk GF, Robinson RA, Hoffman HT. Quantification of surgical margin shrinkage in the oral cavity. *Head Neck* 1997;19(04):281–286
- 144 Egemen O, Bingöl D, Orman Ç, Sayilgan AT, Özkaya Ö, Akan M. Quantification of the surgical margin shrinkage in lip cancer: determining the relation between the surgical and histopathologic margins. *J Craniofac Surg* 2014;25(06):2152–2155
- 145 Mistry RC, Qureshi SS, Kumaran C. Post-resection mucosal margin shrinkage in oral cancer: quantification and significance. *J Surg Oncol* 2005;91(02):131–133
- 146 Umstatter LA, Mills JC, Critchlow WA, Renner GJ, Zitsch RP III. Shrinkage in oral squamous cell carcinoma: An analysis of tumor and margin measurements in vivo, post-resection, and post-formalin fixation. *Am J Otolaryngol* 2017;38(06):660–662
- 147 Nocon CC, Ajmani GS, Bhayani MK. Association of facility volume with positive margin rate in the surgical treatment of head and neck cancer. *JAMA Otolaryngol Head Neck Surg* 2018;144(12):1090–1097
- 148 Amit M, Na'ara S, Leider-Trejo L, et al. Improving the rate of negative margins after surgery for oral cavity squamous cell carcinoma: A prospective randomized controlled study. *Head Neck* 2016;38(Suppl 1):E1803–E1809
- 149 Maxwell JH, Thompson LD, Brandwein-Gensler MS, et al. Early oral tongue squamous cell carcinoma: Sampling of margins from tumor bed and worse local control. *JAMA Otolaryngol Head Neck Surg* 2015;141(12):1104–1110
- 150 Miles BA, Patsias A, Quang T, Polydorides AD, Richards-Kortum R, Sikora AG. Operative margin control with high-resolution optical microendoscopy for head and neck squamous cell carcinoma. *Laryngoscope* 2015;125(10):2308–2316
- 151 Šifrer R, Urbančič J, Strojani P, Aničin A, Žargi M. The assessment of mucosal surgical margins in head and neck cancer surgery with narrow band imaging. *Laryngoscope* 2017;127(07):1577–1582
- 152 Garofolo S, Piazza C, Del Bon F, et al. Intraoperative narrow band imaging better delineates superficial resection margins during transoral laser microsurgery for early glottic cancer. *Ann Otol Rhinol Laryngol* 2015;124(04):294–298
- 153 Hamdoon Z, Jerjes W, McKenzie G, Jay A, Hopper C. Optical coherence tomography in the assessment of oral squamous cell carcinoma resection margins. *Photodiagn Photodyn Ther* 2016;13:211–217
- 154 Francisco AL, Correr WR, Azevedo LH, et al. Fluorescence spectroscopy for the detection of potentially malignant disorders and squamous cell carcinoma of the oral cavity. *Photodiagn Photodyn Ther* 2014;11(02):82–90
- 155 Poh CF, Anderson DW, Durham JS, et al. Fluorescence visualization-guided surgery for early-stage oral cancer. *JAMA Otolaryngol Head Neck Surg* 2016;142(03):209–216
- 156 Cals FL, Bakker Schut TC, Hardillo JA, Baatenburg de Jong RJ, Koljenović S, Puppels GJ. Investigation of the potential of Raman spectroscopy for oral cancer detection in surgical margins. *Lab Invest* 2015;95(10):1186–1196
- 157 Zhang J, Rector J, Lin JQ, et al. Nondestructive tissue analysis for ex vivo and in vivo cancer diagnosis using a handheld mass spectrometry system. *Sci Transl Med* 2017;9:406
- 158 Agrama MT, Reiter D, Cunnane MF, Topham A, Keane WM. Nodal yield in neck dissection and the likelihood of metastases. *Otolaryngol Head Neck Surg* 2003;128(02):185–190
- 159 Agrama MT, Reiter D, Topham AK, Keane WM. Node counts in neck dissection: are they useful in outcomes research? *Otolaryngol Head Neck Surg* 2001;124(04):433–435
- 160 Bhattacharyya N. The effects of more conservative neck dissections and radiotherapy on nodal yields from the neck. *Arch Otolaryngol Head Neck Surg* 1998;124(04):412–416
- 161 Jose J, Coatesworth AP, MacLennan K. Cervical metastases in upper aerodigestive tract squamous cell carcinoma: histopathologic analysis and reporting. *Head Neck* 2003;25(03):194–197
- 162 Kohler HF, Cunha IW, Kowalski LP. Impact of modified radical neck dissections on the number of retrieved nodes, recurrence and survival. *Rev Bras Otorrinolaringol (Engl Ed)* 2010;76(03):374–377
- 163 Truong PT, Vinh-Hung V, Cserni G, Woodward WA, Tai P, Vlastos G. Member of the International Nodal Ratio Working Group. The number of positive nodes and the ratio of positive to excised nodes are significant predictors of survival in women with micrometastatic node-positive breast cancer. *Eur J Cancer* 2008;44(12):1670–1677
- 164 Coburn NG, Swallow CJ, Kiss A, Law C. Significant regional variation in adequacy of lymph node assessment and survival in gastric cancer. *Cancer* 2006;107(09):2143–2151
- 165 Wang J, Hassett JM, Dayton MT, Kulaylat MN. Lymph node ratio: role in the staging of node-positive colon cancer. *Ann Surg Oncol* 2008;15(06):1600–1608
- 166 Rossi CR, Mocellin S, Pasquali S, Pilati P, Nitti D. N-ratio: a novel independent prognostic factor for patients with stage-III cutaneous melanoma. *Ann Surg Oncol* 2008;15(01):310–315

- 167 Spillane AJ, Cheung BL, Winstanley J, Thompson JF. Lymph node ratio provides prognostic information in addition to american joint committee on cancer N stage in patients with melanoma, even if quality of surgery is standardized. *Ann Surg* 2011;253(01):109–115
- 168 Gil Z, Carlson DL, Boyle JO, et al. Lymph node density is a significant predictor of outcome in patients with oral cancer. *Cancer* 2009;115(24):5700–5710
- 169 Kim SY, Nam SY, Choi SH, Cho KJ, Roh JL. Prognostic value of lymph node density in node-positive patients with oral squamous cell carcinoma. *Ann Surg Oncol* 2011;18(08):2310–2317
- 170 Sayed SI, Sharma S, Rane P, et al. Can metastatic lymph node ratio (LNR) predict survival in oral cavity cancer patients? *J Surg Oncol* 2013;108(04):256–263
- 171 Patel SG, Amit M, Yen TC, et al; International Consortium for Outcome Research (ICOR) in Head and Neck Cancer. Lymph node density in oral cavity cancer: results of the International Consortium for Outcomes Research. *Br J Cancer* 2013;109(08):2087–2095
- 172 Yousem DM, Gad K, Tufano RP. Resectability issues with head and neck cancer. *AJNR Am J Neuroradiol* 2006;27(10):2024–2036
- 173 Feinstein AR, Sosin DM, Wells CK. The Will Rogers phenomenon. Stage migration and new diagnostic techniques as a source of misleading statistics for survival in cancer. *N Engl J Med* 1985;312(25):1604–1608
- 174 Champion GA, Piccirillo JF. The impact of computed tomography on pretherapeutic staging in patients with laryngeal cancer: demonstration of the Will Rogers' phenomenon. *Head Neck* 2004;26(11):972–976
- 175 Agnello F, Cupido F, Sparacia G, et al. Computerised tomography and magnetic resonance imaging of laryngeal squamous cell carcinoma: A practical approach. *Neuroradiol J* 2017;30(03):197–204
- 176 Misono S, Rue T, Rajendran J, Davis GE. Effects of upstaging from PET scan on survival in head and neck squamous cell carcinoma. *Head Neck* 2010;32(10):1283–1287
- 177 Basu S, Alavi A. PET-based personalized management in clinical oncology: An unavoidable path for the foreseeable future. *PET Clin* 2016;11(03):203–207
- 178 Jorgensen JB, Smith RB, Coughlin A, et al. Impact of PET/CT on staging and treatment of advanced head and neck squamous cell carcinoma. *Otolaryngol Head Neck Surg* 2019;160(02):261–266
- 179 Joo YH, Yoo IR, Cho KJ, et al. The value of preoperative 18F-FDG PET/CT for the assessing contralateral neck in head and neck cancer patients with unilateral node metastasis (N1-3). *Clin Otolaryngol* 2014;39(06):338–344
- 180 Ivanovic J, Anstee C, Ramsay T, et al. Using surgeon-specific outcome reports and positive deviance for continuous quality improvement. *Ann Thorac Surg* 2015;100(04):1188–1194, discussion 1194–1195
- 181 Shellenberger TD, Madero-Visbal R, Weber RS. Quality indicators in head and neck operations: a comparison with published benchmarks. *Arch Otolaryngol Head Neck Surg* 2011;137(11):1086–1093
- 182 Oosting SF, Haddad RI. Best practice in systemic therapy for head and neck squamous cell carcinoma. *Front Oncol* 2019;9:815
- 183 Khuri SF, Daley J, Henderson WG. The comparative assessment and improvement of quality of surgical care in the Department of Veterans Affairs. *Arch Surg* 2002;137(01):20–27
- 184 Yi SG, Wray NP, Jones SL, et al. Surgeon-specific performance reports in general surgery: an observational study of initial implementation and adoption. *J Am Coll Surg* 2013;217(04):636–647.e1
- 185 Hatfield MD, Ashton CM, Bass BL, Shirkey BA. Surgeon-specific outcome reports in general surgery: Establishing benchmarks for peer comparison within a single hospital. *J Am Coll Surg* 2016;222(02):113–121
- 186 Weber RS, Lewis CM, Eastman SD, et al. Quality and performance indicators in an academic department of head and neck surgery. *Arch Otolaryngol Head Neck Surg* 2010;136(12):1212–1218
- 187 Lewis CM, Monroe MM, Roberts DB, Hessel AC, Lai SY, Weber RS. An audit and feedback system for effective quality improvement in head and neck surgery: Can we become better surgeons? *Cancer* 2015;121(10):1581–1587
- 188 Agency for Health Care Research and Quality. US Dept of Health and Human Services. Your guide to choosing quality health care. <https://archive.ahrq.gov/consumer/qnt/>. August 5, 2020.
- 189 Lira RB, de Carvalho AY, de Carvalho GB, Lewis CM, Weber RS, Kowalski LP. Quality assessment in head and neck oncologic surgery in a Brazilian cancer center compared with MD Anderson Cancer Center benchmarks. *Head Neck* 2016;38(07):1002–1007
- 190 Sedgwick P, Greenwood N. Understanding the Hawthorne effect. *BMJ* 2015;351:h4672
- 191 Schwartz D, Fischhoff B, Krishnamurti T, Sowell F. The Hawthorne effect and energy awareness. *Proc Natl Acad Sci U S A* 2013;110(38):15242–15246